

**Final Report of NASA Grant NCC3-817**

**New Solid Polymer Electrolytes for Improved Lithium Batteries**

Cleveland State University

Dr. David G. Hehemann  
June 4, 2002

## Introduction:

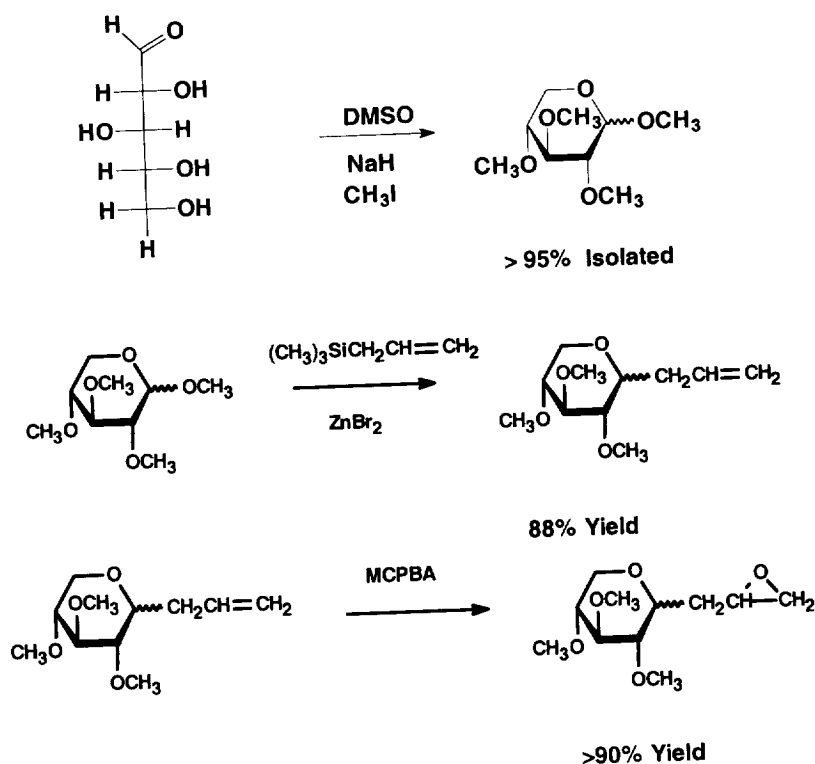
The objective of this work was to identify, synthesize and incorporate into a working prototype, next-generation solid polymer electrolytes, that allow our pre-existing solid-state lithium battery to function better under extreme conditions. We have synthesized polymer electrolytes in which emphasis was placed on the temperature-dependent performance of these candidate electrolytes. This project was designed to produce and integrate novel polymer electrolytes into a lightweight thin-film battery that could easily be scaled up for mass production and adapted to different applications.

## Synthetic approach:

We have chosen to use as our model a novel carbohydrate based system. Incorporation of carbohydrates into polymer chains not only provides the means to readily incorporate and transport lithium ion but also provides a means to lower the crystallization onset temperature,  $T_g$ , of the polymeric material. Both these characteristics are desirable for a polymer electrolyte aimed at use in an aerospace environment.

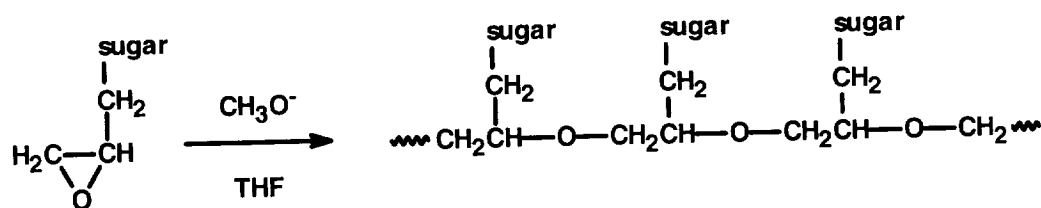
We have undertaken the preparation and optimization of all steps for synthesis of an electrolyte Xylose based monomer as outlined in the following scheme. This sequence involves,

Scheme I



(1) permethylation of Xylose, (2) Lewis Acid mediated allylation of permethylated Xylose, (3) epoxidation of the allyl moiety. Four analogues of Xylose were also made. Each reagent prepared was fully characterized via multi-nuclear NMR, and GC/MS spectroscopic techniques. Initial experiments to prepare polymer chain of 100 units based on the Xylose derivative were undertaken, and are now being optimized. The polymerization scheme outlined in Scheme II is the basic method being followed.

Scheme II



We have also tested polymer electrolytes containing both crown-ethers, polycrown-ethers, monosaccharide, and polysaccharides. Thus far we have found that the carbohydrate containing polymer has quite high conductivity and appears promising as a new electrolyte for Lithium ion batteries. In addition, we have done testing of in-house and externally produced material in breadboard batteries for use in modeling systems for satellite use.